PPR Episystem

A Concept to Guide PPR Eradication Strategy

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Episystems: A Concept to Guide Eradication Strategy

A virus episystem is a set of interconnected host population capable of maintaining circulation and transmission of the virus indefinitely

The role of specific sub-populations in the episystem determines when, where and how actions should be taken to achieve eradication

Management and monitoring should be based on the episystem and the strategy to interrupt virus circulation in the episystem.

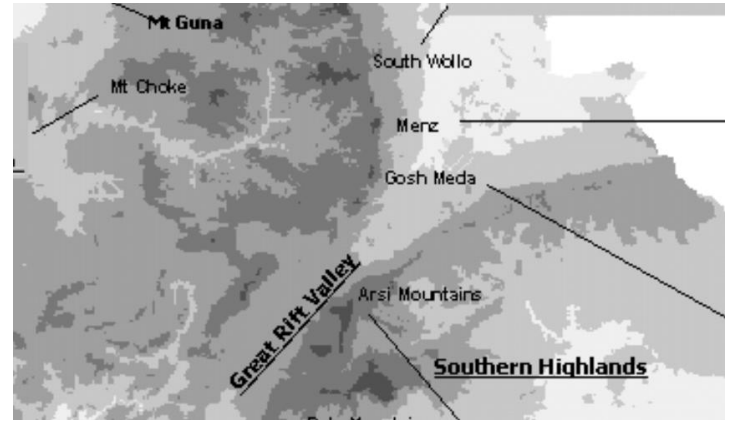
Core populations

- The core of an episystem is the population component capable of sustaining PPR virus transmission over prolonged periods

  - For PPR - Domestic small ruminants

Core populations

- **Not all susceptible species have been shown to transmit PPR to the extent that they have a practical role in enabling virus maintenance**
  - **Cattle**
  - **Wildlife**
  - **Camels**



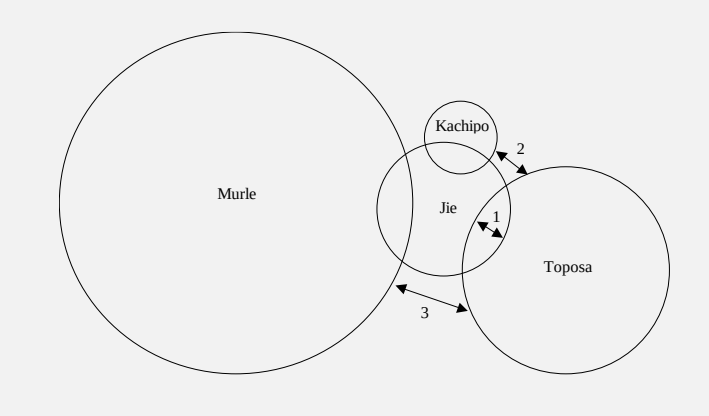
Vial, 2010

These are considered dead-ends that do not contribute to virus maintenance

The Structure of Episystems

An episystem:

- May consist of one large population but more commonly consists of several interlinked sub-populations
- Small ruminant holdings of an ethnic community often share common herding and contact patterns and can be considered a population
- Movement and transhumance over a geographical area is often a feature that must be considered
- Can include value chains or marketing chains
- Can be a network of populations at different locations and not necessarily in a contiguous zone



Episystems typically transcend international borders and may involve more than one regional economic community

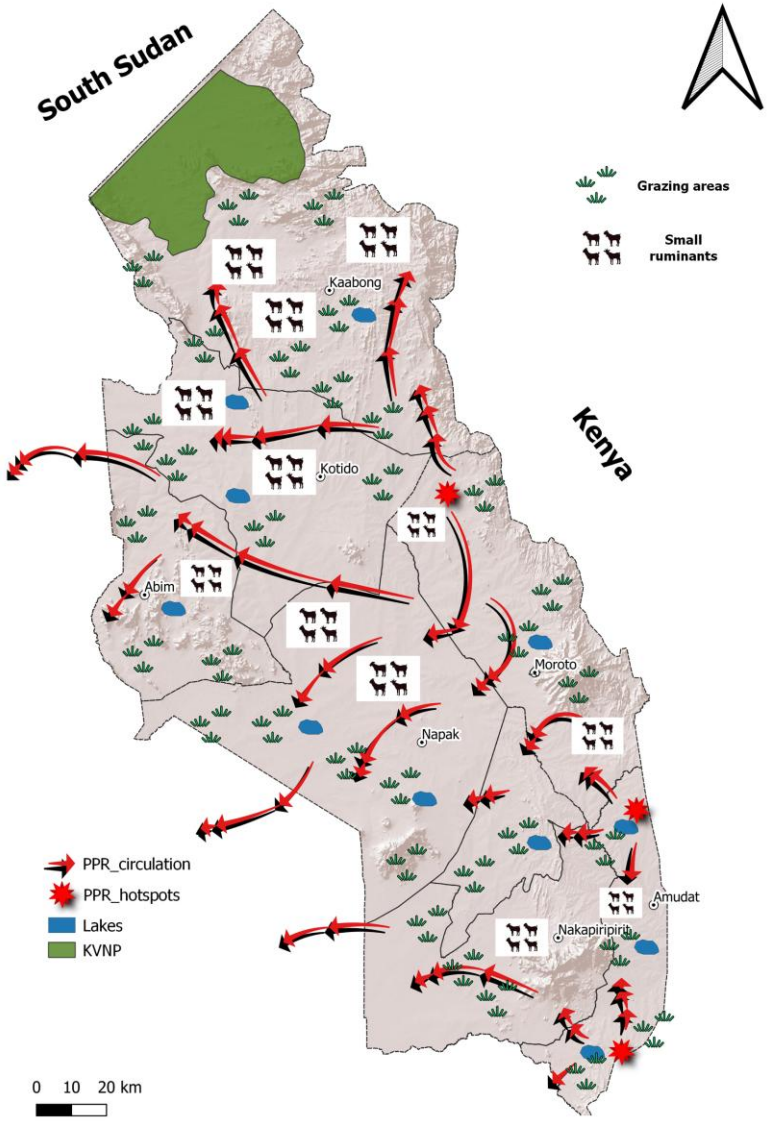
Planning strategies

Which are the core populations?

Which are the peripheral populations?

Where do you focus vaccination to stop the cycle?

The 20:80 rule: 20% of the population accounts for 80% of the transmission



Episystems description and assessment

- A description of the farming systems operating in any given country is a preliminary step to assess which sub-populations are candidate to be part of an episystem (starting point to assess episystem)
- Main determinants to be considered:
  - Mobility
  - Contact patterns
  - Access to animal health services

Episystems description and assessment (mobility)

- The following definition of farming systems based on the criteria of mobility is taken from Robinson, T.P. *et al* (Global livestock production systems).

  - **Total nomadism: no permanent place of residence, no regular cultivation.**
  - **Semi-nomadism: a permanent place of residence exists, supplementary cultivation is practised, but for long periods of time animal owners travel to distant grazing areas.**
  - **Transhumance: a permanent place of residence exists, their herds are sent to distant grazing areas, usually on seasonal cycles.**
  - **Partial nomadism: characterized by farmers who live continuously in permanent settlements and have herds at their disposal that graze in the vicinity.**
  - **Stationary animal husbandry: animals remain on the holding or in the village throughout the year.**

Episystems description and assessment (contact patterns – key concepts)

- No long-term carrier state at individual animal level (duration of infectivity relatively short at individual level)
- Within-herd transmission occurs through close contacts between an infected and a susceptible individual
- Indirect transmission less important
- The overall duration of infectivity at herd level determined by the size of the herd
- In a close herd with no contact infection will fade out
- The possibility for the virus to survive for prolonged periods is to jump from infected to susceptible herds (contact patterns between herds)

Episystems description and assessment (contact patterns – key concepts)

- Value chains may also be an important determinant to transfer infection
- Live animal markets may play an important role as super-spreaders (hyper-dynamic population constantly changing)
- Challenging issue if entering and exiting from Live Animal Markets is unregulated

Episystems description and assessment (access to animal health services)

- Reported PPR outbreaks may not necessarily be a true representation of where the virus is circulating
- Outbreak reports might be often a consequence of infection in areas with effective surveillance mechanisms, or relatively higher animal health infrastructure, whereas the virus may predominantly be circulating in areas with weak surveillance and/or weak animal health services deliveries (remote and hard-to-reach areas)
- These areas may need a specific focus

Episystems description and assessment (tools available)

- The heart of assessing national PPR epidemiology (Stage 1 of the PPR pathway)
- Conventional and participatory epidemiological to characterize:
  - Sub-populations in terms of mobility, contact patterns, outbreak patterns
- Analysis of the genetic sequence and clustering (molecular epidemiology) of strains detected in an episystem are:
  - The best epidemiological supporting tool to delineate systems
  - Easily achievable if appropriately planned
  - Internationally available services for testing and analysis

The Role of Participatory Epidemiology and Molecular Epi

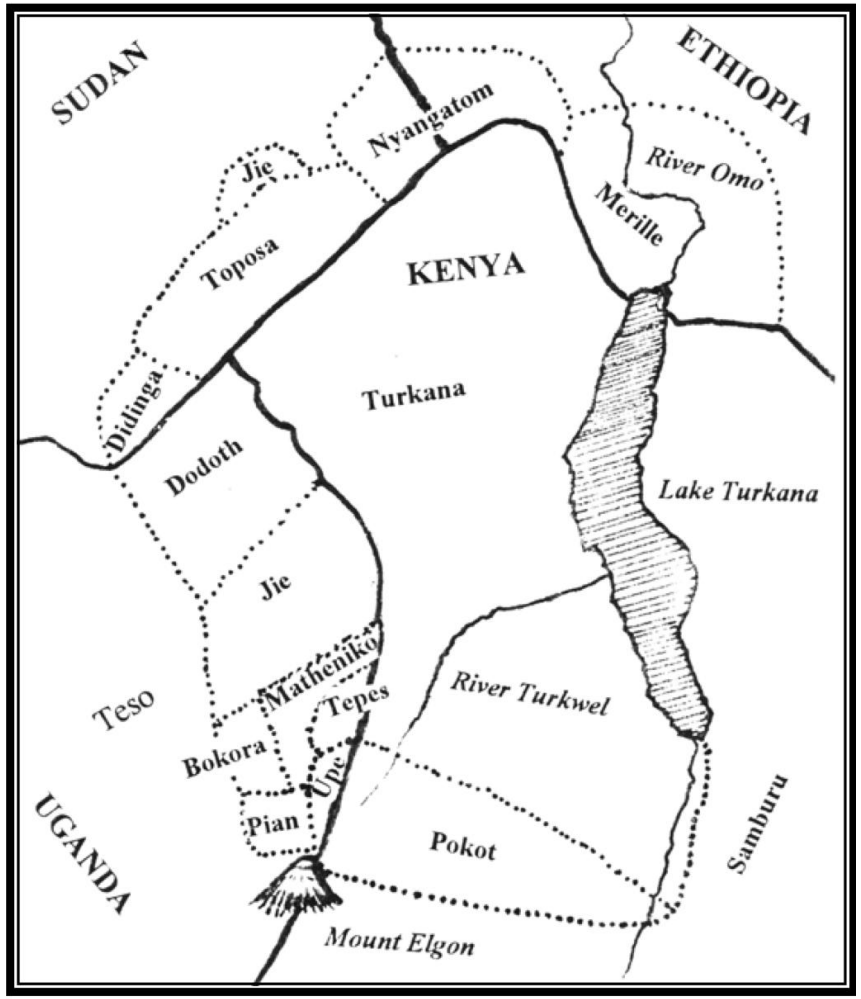
- Understand risk from the ground up
- Triangulation of information
  - Multiple methods and multiple sources
  - Diverse types of information
  - Includes biological test data
  - Interactive risk mapping
- Best bet scenario for the episystem
- Testing episystem hypotheses through molecular epi
  - Cluster analysis
  - Ancestor analysis and divergence timelines

Examples of PPR Episystems

Example 1: Karamoja

Karamojong cluster

- Areas of Uganda, Kenya, South Sudan and Ethiopia
- Herds of Turkana, Karamojong, Jie, Dodoth, Toposa, Nyangatom and Pokot
- Defined homestead areas with complex transhumance and livestock exchange patterns



Example 2

Lake Chad Basin

- Communities from Central African Republic, Chad, Cameroon, Nigeria and Niger
- Fulani (about 90%) and other pastoral groups (e.g. Toubou and Gorane) practice long distance transhumance, intermingle and share the landscape for pasture and water in the dry season.
- Patterns are changing due to the drying of the lake
- Return to their respective countries in the rainy season

Example 3 – PPR targeted vaccination in Afghanistan

Kuchi community

- A significant part of this social community is engaged in livestock
- Nomadic pastoralists
- Sheep and Goat population belonging to the Kuchi community accounts for almost 30% of the overall small ruminants population in the country
- Preliminary risk assessment identified the small ruminants belonging to this community as candidate to play major role in maintaining PPRV over time
- Fulfills the criteria of high mobility, frequent contact patterns within the overall Kuchi community (critical community size) and weaker access to animal health delivery system (if compared with sedentary livestock keepers closer to urban areas)

Example 4 – Cattle colony farming system (last foci of Rinderpest in Pakistan)

- The dairy colony production system has some peculiar characteristics. The animals are kept on individual farms for milk production but only for the period of their lactation (230-300 days), so recently calved are purchased and brought onto the colony farms from the breeding areas located mainly in Punjab.
- Dairy colonies are distributed across the country close to major cities
- The largest dairy colony is located in the outskirt of Karachi (Sindh province) with more than 400,000 animals distributed across a miriad of livestock keepers spread over an area of 6.5 square Km (huge animal density)
- The main determinant for virus persistence (FMD is hyper-endemic) is the replacement rate (10%-12% on a monthly basis) which means that, on average, 40,000 animals are introduced every month

PPR Episystems (conclusions)

- Eradication strategies and implementation plans need to address episystems in a holistic and integrated manner
- Requires an accurate understanding of the international nature (if exists) of episystems
- Conventional and participatory epidemiology offer good tools for characterizing episystems
- Molecular epidemiology as a supporting tool for confirming the extent and structure of episystems.
- Interventions should target the core populations responsible for maintaining PPR virus and sustaining transmission
- Often requires integrated international action

Thank you

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